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OF THE BUREAU OF STANDARDS

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TWENTY-FIRST NATIONAL CONFERENCE ON WEIGHTS AND MEASURES

The Twenty-First National Conference on Weights and Measures was held at the Bureau of Standards on May 22 to 25, inclusive. The following outstanding accomplishments resulted from this conference: Final regulations for lubricating-oil bottles and a new code of specifications and tolerances for grease-measuring devices were adopted; final action was taken on a series of amendments to the regulations for liquid-measuring devices and, largely for purposes of clarification, a series of amendments to the regulations previously adopted for linear, fabric measuring, and liquid capacity measures, vehicle tanks, and scales were adopted. Based

upon an investigation conducted by the bureau, the transmission drive for taximeters was indorsed.

In point of attendance and the number of States represented the conference surpassed all previous ones. Delegates were present from 28 States and the District of Columbia, and the registration of delegates and official guests reached 246, of which number 127 were weights and measures officials or representatives. States having delegates in attendance were as follows: Alabama, California, Connecticut, Delaware, District of Columbia, Florida, Georgia, Illinois, Indiana, Kentucky, Maine, Maryland, Massachusetts, Michigan, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oregon, Pennsyl-

vania, Rhode Island, South Carolina, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

The opening address of the president of the conference, Dr. George K. Burgess, was of particular interest. It was devoted largely to a refutation of the misleading and incorrect statements which have been so generally circulated recently among weights and measures officials and manufacturers relative to H. R. 7208, the bill introduced into the present Congress at the instance of the Twentieth National Conference on Weights and Measures, "A bill to regulate and control the manufacture, sale, and use of weights and measures and weighing and measuring devices for use or used in trade and commerce, and for other purposes." Doctor Burgess included in his address a résumé of the provisions of this bill, a statement of the facts leading up to its introduction into Congress, answers to a number of questions relating thereto originating with the American Institute of Weights and Measures, and a statement of the attitude of the National Bureau of Standards toward the agitation for and against the compulsory adoption of the metric system of weights and measures for the United States, a subject which some persons have confused with the object of the above bill. In this connection he said:

As to the attitude of the Bureau of Standards in relation to the compulsory adoption of the metric system, we may state that the facts in the case are that in relation to all proposals advocating the compulsory adoption of the metric system of weights and measures in the United States the policy of the Bureau of Standards is one of neutrality—neither to advocate nor to discourage. The whole subject of compulsory adoption is a highly controversial one, and diametrically opposite views are being freely voiced. Most of these are matters of opinion, and definite facts are difficult to obtain. So many factors enter into the equation of compulsory adoption that the bureau is disinclined to make the attempt to evaluate it and thus throw the weight of its decision upon the one side or the other. Therefore, I can say definitely and emphatically that the bureau is not advocating the adoption of the metric system for commercial

or industrial uses, whether by legislation or otherwise, nor has it ever done so during the period that I have been director of the bureau.

Aside from numerous technical subjects considered, the conference program featured several addresses by representatives of business and industry. O. C. Adams, president of the Southern Division of the Great Atlantic & Pacific Tea Co., spoke upon the weights and measures aspects of chain-store operation and described the steps taken by his organization to meet, and in some instances to anticipate, weights and measures regulations. The general manager of the National Better Business Bureau, Edward L. Greene, told the conference of many specific instances in which there had been splendid cooperation between weights and measures officials and local better-business bureaus. The reweighing of loads of coal, check-ups on gasoline purchases, the reweighing of packages of commodities put up by local dealers, and certain investigations of advertised claims were among the examples cited as typical of a general program on the part of the better-business organizations to support and assist in the supervisory activities of the weights and measures official. A. Bousfield, chief engineer of the E. & T. Fairbanks Co., gave a very interesting presentation of the subject, "The development of industry," which he illustrated with a large number of lantern slides.

One of the important subjects considered at the conference was the testing of gasoline meters. This subject was presented in two parts, first, testing in the field as carried on by weights and measures officials and, second, testing in the factory as carried on by the manufacturers of meters. Papers describing their methods of conducting field tests were presented by William Foster, city sealer of Springfield, Mass.; Theo. A. Seraphin, district supervisor of weights and measures of Philadelphia, Pa.; Frank Berka, deputy sealer of Los Angeles, Calif.; and John A. Stephenson, city sealer of Rochester, N. Y. Speaking of their respective companies, C. P. Griffith,

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of S. F. Bowser & Co.; George D. MacVeagh, of the National Meter Co.; A. D. MacLean, of the Pittsburgh Equitable Meter Co.; and H. F. Barrett, of the Buffalo Meter Co., told of the equipment and methods followed in the factory testing of meters designed for dispensing gasoline at filling stations.

A varied and interesting group of papers was presented by weights and measures officials. Joseph J. Rogers, assistant superintendent of weights and measures of New Jersey, described the recently acquired heavy-scale-testing equipment of his State, while the equipment and methods being utilized in Texas in the regulation of gas, electric, and water meters were described by W. T. Hendrichson, meter inspector of the State division of weights and measures. J. H. Meek, director of the division of markets of Virginia, spoke on cooperation among weights and measures officials to the end that more nearly uniform regulations may be promulgated and enforced by the several States, while a unique and highly successful method of promoting interest in weights and measures supervision in a given community by essay contests in the high schools was described in a paper prepared by James J. Dawson, inspector of standards of Massachusetts and the originator of the plan. In the absence of Mr. Dawson, this paper was presented to the conference by Francis Meredith, director of standards for Massachusetts. The efforts of two State weights and measures associations to keep their members in touch with one another between annual meetings of the association, through the medium of publications supported by the associations, was told by the editor of one of these publications, A. W. Corwin, county sealer of Allegany County, N. Y. H. N. Davis, deputy commissioner of weights and measures for Vermont, told of the serious effects upon weighing equipment of the recent flood conditions in New England and of the immediate calls made upon weights and measures officials to recondition this equipment for

emergency use in the distribution of supplies throughout the stricken area.

Of interest in connection with the testing of heavy-capacity scales was the description given by H. W. Hem, of the Toledo Scale Co., of the testing device recently developed by his company. This device is designed to test a scale up to 20,000 pounds and is an outgrowth of the earlier devices of similar character, but much smaller capacity, which this company has also made.

Some features of the installation of the new plate-fulcrum, master railroad track scale of the Bureau of Standards at Clearing Yard, Chicago, were described by H. M. Roeser, of the bureau, who had charge of this installation. This scale will be used for the purposes of calibrating railroad-owned track-scale-testing cars, the test cars and weights belonging to the Bureau of Standards, large weights for industrial uses, etc. The master scale is housed in a special building suitably equipped for carrying on the activities of a testing depot and will be in charge of members of the track scale section of the Bureau of Standards.

I. J. Fairchild, of the commercial standards unit of the bureau, reviewed the development of this unit and described some of the various projects at present occupying the attention of its personnel. Commercial standards, it was explained, are standards which the producers want as a guide for fabrication, and define articles which the distributors want to stock and which the consumers want to buy. In the establishment of commercial standards, the Bureau of Standards relies entirely upon cooperation, and in this field makes no suggestions relative to the standards except upon special request for advice. The procedure is a natural outgrowth of the movement toward the elimination of waste in industry through the limitation of unnecessary variety or the restriction of needless diversification of types, sizes, colors, etc.

A proposed publication of the Bureau of Standards was announced in a paper

presented by William Parry, of the bureau. A digest of weights and measures cases is planned, to present in one volume an index to weights and measures cases decided throughout the United States, with special analyses appended in connection with those involving outstanding or unusual principles. This publication should prove valuable to all weights and measures officials who have occasion from time to time to present cases in court, for they will be enabled to locate readily decisions previously rendered on similar questions in their own or other States.

A report of the investigation of the Bureau of Standards on the transmission drive for taximeters was made by Ralph W. Smith, who stated the conclusion that, as a result of many observations made on taxicabs and a private car equipped with two meters each, one driven from the front wheel and the other from the transmission, the differences in registration were negligible from the weights and measures standpoint. He added that, in view of numerous advantages which the transmission drive appears to possess as compared with the front-wheel drive, it was recommended that the former be accepted by officials as a proper method of installation for taximeters. Later, the conference, by resolution, went on record as being in agreement with these conclusions.

The special committee on legislation, appointed at the last conference, reported the preparation and introduction into Congress of H. R. 7208, "A bill to regulate and control the manufacture, sale, and use of weights and measures and weighing and measuring devices for use or used in trade or commerce, and for other purposes." This action was taken in conformity with the instructions of the twentieth national conference. In presenting this report, the chairman of the committee, E. J. Maroney, sealer of weights and measures of New Haven, Conn., denounced recent attacks made upon the National Bureau of Standards in connection with the bill in question

by those opposing its passage. Later in meeting Mr. Maroney presented a petition for the signature of the members of the conference, this petition setting forth the facts in relation to the introduction of the conference bill and asserting the confidence of the conference in the integrity of the motives of the Bureau of Standards.

The newly elected officers of the National Conference on Weights and Measures are as follows: President, Dr. George K. Burgess, Director of the Bureau of Standards; first vice president, H. L. Flurry, chief of the division of weights and measures for Alabama; second vice president, Francis Meredith, director of standards for Massachusetts; secretary, F. S. Holbrook, cochief of the division of weights and measures of the Bureau of Standards; and treasurer, George F. Austin, sealer of weights and measures for Detroit, Mich.

At the twentieth national conference, held last year, it was decided that in the future there should not be more than one member on the executive committee of the conference from any given State. In accordance with this decision the following executive committee was elected: All of the officers, ex officio; W. F. Cluett, of Illinois; H. N. Davis, of Vermont; Thomas Flaherty, of California; William Foster, of Massachusetts; S. T. Griffith, of Maryland; T. F. Mahoney, of Tennessee; E. J. Maroney, of Connecticut; I. L. Miller, of Indiana; A. B. Smith, of Pennsylvania; W. A. Payne, of New York; V. A. Stovall, of Texas; C. V. Fickett, of Maine; B. W. Ragland, of Virginia; C. W. Roberts, of the District of Columbia; W. F. Steinel, of Wisconsin; H. A. Webster, of New Hampshire; H. S. Jarrett, of West Virginia; J. H. Foley, of New Jersey; and M. A. Bridge, of Ohio.

CONFERENCE OF UTILITY COMMISSION ENGINEERS

The sixth annual conference of State utility commission engineers, held at the bureau May 31 and June 1, was attended by 24 engineers from 12 States, the Dis-

trict of Columbia, and two Provinces of Canada. The widespread interest in these meetings is shown by the fact that California, Oklahoma, Iowa, Wisconsin, Florida, and Alabama were represented, in addition to most of the northeastern States which have commissions actively interested in engineering problems.

The value of these conferences arises not merely from the engineering papers presented and discussed, but even more from the personal contacts established, the opportunity to compare experience, and the interchange of information as to the way in which the engineering organizations of the several States operate. Questions of a more or less detailed sort arising from the operations of the commissions constitute a large part of the program. Since these questions are treated from the point of view of the commissions rather than in their more general aspects, the proceedings of the conference are not published.

The bureau acts as host for these conferences, but the programs are arranged by a committee of the engineers and include commission problems outside the scope of the bureau's work. The papers included in this year's program were as follows: Depreciation in connection with appraisals, by H. Carl Wolf, chief engineer, Maryland Public Service Commission; Effect of reduced cost of steam generation on development and potential value of water powers, by C. M. Larson, chief engineer, Railroad Commission of Wisconsin; A fuel-price clause in rates for domestic and commercial gas service, by A. G. Mott, chief engineer, California Railroad Commission; Inducement form of rate for residential use of gas and electricity, by C. R. Vanneman, chief engineer, New York Public Service Commission; Development of rural electric service in California, by A. V. Guillou, assistant chief engineer, California Railroad Commission; Gas service problems in connection with the revision of Bureau of Standards Circular No. 32, by E. R. Weaver, chemist, Bureau of Standards; Accidents and approved protective de-

vices at grade crossings of railroads and highways, by E. Irvine Rudd, chief engineer, Connecticut Public Utilities Commission; Discussion of fourth edition of National Electrical Safety Code, by M. G. Lloyd, electrical engineer, Bureau of Standards.

The committee elected to take charge of the 1929 conference consists of A. G. Mott, chief engineer, Railroad Commission of California, chairman; Col. Philander Betts, chief engineer, New Jersey Board of Public Utility Commissioners, vice chairman; I. F. McDonnell, chief engineer, Alabama Public Service Commission; and J. Franklin Meyer, of the bureau, as secretary.

ELECTROLYSIS SURVEYS BY LOCAL UTILITIES COMPANIES

Within the last year the Bureau of Standards has had several requests for assistance in determining the condition of underground structures with respect to electrolytic corrosion. The bureau's staff of electrolysis engineers has been reduced to one man, and it is no longer conducting field research in electrolysis. It is possible, however, in some cases to assist local utilities in improving their electrolysis conditions if all of the utilities concerned in a given locality are willing to cooperate. At present the bureau's engineer is directing two electrolysis surveys—one in Buffalo and the other in Duluth. In each case a local electrolysis committee has been formed, and a local engineer selected to collect data with the assistance of men furnished by each of the cooperating utilities.

From time to time the bureau's engineer visits the electrolysis committees and advises them as to what data are needed, the interpretation of their results, and the steps to be taken to improve electrolysis conditions. The entire expense of the survey is borne by the local utilities. This method of handling electrolysis problems seems to have some advantages in cases where the local utilities wish to solve their own problems without the assistance of a consulting en-

gineer. Not the least of these advantages is the better understanding by each local engineer of the viewpoints and problems of utility organizations other than his own.

CODE FOR ELECTRICITY METERS

The third edition of the code for electricity meters has been issued by the sectional committee that has had the revision in charge. The Bureau of Standards, the Association of Edison Illuminating Companies, and the National Electric Light Association have been the sponsors for the project under American Engineering Standards Committee procedure. The chairman of the sectional committee was a member of the staff of the bureau, and the work of revision has been carried on under his direction. On the sectional committee were representatives of the manufacturers of electricity meters, of public-utility companies, public-service commissions, municipal electricians, scientific instrument makers, and testing and research laboratories.

The code contains chapters on definitions, standards, metering, installation methods, laboratory and service tests, and specifications for the acceptance of types of watt-hour and demand meters, and auxiliary apparatus for use with meters. It is published by the National Electric Light Association (420 Lexington Avenue, New York, N. Y.), one of the sponsors, from whom copies are obtainable at \$2 each.

AIRPLANE RADIOBEACON VARIATIONS OVERCOME

In the work which the bureau is carrying on to develop radio aids to air navigation it was necessary to determine the reliability of the crossed-coil radiobeacons which are used to guide aircraft. Experience has shown that the beacons are very reliable in the daytime up to the limit of their distance range. There has been, however, very little information on night reliability.

A series of night flights between Cleveland and New York was made, observing principally the beacon at Bellefonte,

Pa., in the middle of the Allegheny Mountains. These flights showed that the beacon was very reliable at night up to a distance of 25 miles and gave accurate bearings most of the time up to 50 miles. Beyond 100 miles bearings observed in this series of flights were usually of questionable value.

Observations made on the ground and in the air indicate that the cause of this shifting of the radio course is a distortion that is introduced in the radio waves as they travel through the upper atmosphere. The nature of this distortion has been carefully studied and analyzed. It is especially pronounced in mountainous regions. By using special antenna arrangements for receiving, it has been found that these shifts can be practically eliminated.

The flights mentioned were made with the old type of airplane antenna consisting of a long trailing wire. Such antennas, by reason of hanging down at a slanting angle, do not have the necessary characteristics to eliminate the effect of false radio course indications at night. A new type of antenna consisting of a vertical 10-foot metal pole has been developed by the Bureau of Standards. The use of so short an antenna has been made possible by the development of a new and specialized type of aircraft receiving set. This antenna is expected to be a great boon to aviation, as recent flight tests have indicated that it practically eliminates all errors in the indications of the radiobeacon, showing the course where it actually is at all times.

It is furthermore probable that there will be special conditions on some of the airways requiring the radiobeacons in some regions to be spaced closer together than at first contemplated, with corresponding reduction in the power used by each. At short distances there is no distortion of the course indication. Thus, it is expected that the combination of the new antenna with this modified plan for closer beacon spacing will eliminate these night effects and make the radiobeacon an accurate device for air navigation under all conditions.

The study of these variations is reported in a paper, "Apparent night variations with crossed coil radio beacons," by Haraden Pratt, which appeared in the Proceedings, Institute of Radio Engineers for May, 1928, page 652.

RADIOTELEPHONE COMMUNICATION FROM AN AIRPLANE

In cooperation with the committee which managed the All America Aircraft Show, held in Detroit, Mich., April 14 to 21, the bureau installed and operated radiotelephone equipment on a Ford trimotor airplane. This airplane was used as a flying studio for the broadcasting of speeches and music during the show. Programs originating on the airplane were received on the ground, relayed by wire to a Detroit broadcasting station, and rebroadcast by that station. During each flight an explanation was given as to just how the broadcasting was being carried on and the outstanding technical features involved. Flights were made at night, when there was a large radio audience, and reports received from all parts of the country, as well as from the people in and around Detroit, showed that the programs reached a large number of people, and in a very effective way brought to their attention the possibilities of radio communication in air navigation. The flights made were an outstanding feature of the show.

THE STATUS OF FREQUENCY STANDARDIZATION

In a paper which appeared in the May, 1928, Proceedings of the Institute of Radio Engineers, page 579, under this title, J. H. Dellinger, chief of the radio section of the bureau, shows that frequency standardization of hitherto laboratory character only has become of first-rank importance in reducing radio interference. The recent International Radio Conference recognized frequency as the cornerstone in the radio structure by devoting its major attention to a frequency allocation to provide for the orderly development of all radio services.

Because of increasing use of all available radio channels, particularly those

for broadcasting and the very high frequencies, the requirements of frequency measurements are a hundred times more rigorous than they were five years ago. The perfection of standards and measurements to the necessary accuracy requires the most intensive work by the Government and by various large organizations to produce standards and instruments that can be used to keep radio stations each operating on its own channel. This development has been facilitated by a special cooperative plan organized by the Bureau of Standards a year ago and involving the Commerce, Navy, and War Departments, the General Electric Co., the Westinghouse Co., American Telephone & Telegraph Co., Radio Corporation of America, and the General Radio Co.

Piezo oscillators are now available to hold radio station frequencies extremely constant. For instruments of this type equipped with temperature control, national and international comparisons have shown that they are reliable to a few parts in 100,000.

This brings in sight the possibility of the use of special piezo oscillators in broadcasting stations, which will hold the frequency so close that several such stations can operate simultaneously without heterodyne interference on the same frequency. This is the only practical scheme so far developed for solving the problem of too many broadcasting stations.

The use of frequency standards of this high accuracy is also vital to all users of very high frequencies. Many more high-frequency channels will become available when all stations use the best available frequency standards and keep the stations on their frequencies with great accuracy.

MEASUREMENT OF LARGE VOLUMES OF GAS

This is the fourth year in which the Bureau of Standards has actively cooperated with the gas-measurement committee of the Natural Gas Department of the American Gas Association on methods for measuring large volumes of gas.

In 1925, the first year of this work, the committee conducted some tests on three orifices against a covered gas holder, made available for the work by the East Ohio Gas Co., of Cleveland, Ohio. The object of these tests was to determine the discharge coefficients for these orifices under very definite and limited conditions.

The next year, 1926, the work undertaken was a study of the effects of many types and combinations of pipe fittings at various distances from the orifice and also the effectiveness of different designs of straightening vanes in eliminating the disturbances produced by the fittings. As a result of this work, which was conducted at the plant of the Iroquois Gas Corporation, Buffalo, N. Y., the committee prepared and issued a tentative code on the installation of orifice meters. Copies of this code may be obtained by writing to the American Gas Association, Natural Gas Department, New York, N. Y.

During 1927 the work of 1926 continued, using a slightly modified set-up to check the disturbance measurements. Several important conclusions have been drawn from these experiments, among them the following:

When a swedge is used upstream from the orifice, straightening vanes must not be used between the swedge and orifice if a larger orifice flange is installed.

Disturbances caused by a combination of various fittings have an effect proportional to the distance of the disturbance from the orifice in terms of pipe diameter. In other words, the usual theory of geometrical relationships is found to hold.

Last year an extensive series of tests was started in order to study the effect on the discharge coefficient of changing the rate of flow. This series served as a check on similar tests made by the Bureau of Standards at Edgewood Arsenal and showed changes of the same kind and approximately the same magnitude as recorded in the previous tests.

During the coming summer the work at Buffalo will be continued in line with a program decided upon some time ago.

The preliminary arrangements included the installation of a new 4-inch pipe in a so-called commercial line, with two orifice flanges. Tests will be made with 25, 50, and 75 per cent diameter ratio orifices at the highest possible pressure, followed by ones at lower pressures.

When making the tests at high-line pressures, it will be necessary to make some auxiliary tests on the gas itself to determine its supercompressibility; that is, its deviation from Boyle's law, and also to determine the specific gravity of the gas as referred to air. An instrument for determining the supercompressibility of a gas has been constructed at the bureau, and trials tests with it on air and carbon dioxide have given results in satisfactory agreement with existing data.

After these tests, and with the 4-inch line still in place, the rate of flow tests will be checked, using 25, 50, and 75 per cent orifices. The 4-inch will then be replaced by a 12-inch line set up with vanes and pressure taps at points geometrically similar in location to those used last year for the 8-inch line and tests made with 25, 50, and 75 per cent (diameter ratio) orifices at rates of flow as high as can be obtained.

If the results of tests on the 4 and 12 inch lines indicate the need for further work on orifices or pipes of other sizes, such as 2-inch pipe, this work will be undertaken if time permits. In addition, tests on 6 by 8, $6\frac{1}{2}$ by 8, and 7 by 8 inch orifices have been recommended in order to indicate the probable accuracy of measurements in these sizes.

Tests to supplement those on the 4-inch line at high static pressures will probably be carried out at another location, where pressures up to at least 350 lbs./in.² are available. These tests would be started as soon as those on the 4-inch line at Buffalo are completed and would be carried along with the other runs. This will mean that two crews will be kept at work for a large part of the time. H. S. Bean, chief of the gas-measuring instrument section of the bureau, has been assisting the committee in developing its program, and since last

year has been in charge of the actual testing.

The question of extending these investigations to some midcontinental field, where pressures of 600 lbs./in.² or more are available, is being considered by the committee. This is an important question, because there are already in service transmission lines with working pressures of 500 lbs./in.² or higher. Some tests may also be needed on casing-head gas at subatmospheric pressures. These tests would be complicated by the presence of condensable vapors and fog. It is from casing-head gas that most of natural-gas gasoline is recovered, a most important by-product of the industry.

DENTAL RESEARCH

Satisfactory progress is being made on the dental research program now being carried out in cooperation with the American Dental Association. Dr. N. O. Taylor, research associate representing the association, is making a survey of the amalgam alloys used by the profession. These are being tested for compliance with the United States master specification for this material.

The cooperative research with the association is a very efficient arrangement and will make possible the application of the important discoveries and findings secured in the recently completed research.

Results of this latter research are now in press and will be available in a few months. The exact date of issue will be announced in this bulletin.

The association research will be extended to the inlay, partial denture, and laboratory testing fields at an early date. Reports on this work will be made as sufficient data are secured.

METALLURGICAL ADVISORY COMMITTEES

The annual meeting of the metallurgical committees advisory to the Bureau of Standards was held at the bureau May 11 and 12 and was attended by some 50 out-of-town metallurgists (committee members and invited guests), 10 representatives of other Government departments, and 40 of the bureau's staff. The progress of the past year's work

was shown by exhibits of specimens, charts, new apparatus, and reports published during the year; by demonstrations in the laboratory; and by verbal explanation. Many new research problems in metallurgy, which representatives of the industries had requested that the bureau take up, were discussed and a few of them approved for study if the industries wish to support them on the research associate plan or when funds are available. The committee was not in favor of abandoning any of the current projects, which were considered to be of fundamental importance and deserving of continuation.

APPARATUS FOR OBSERVATION OF THERMAL EXPANSION OF REFRACTORIES FROM 20 TO 1,800° C.

The increasing use at high temperatures of fire-clay refractories and special refractories makes it desirable to add to the present knowledge on the expansion behavior of these materials at elevated temperatures. The bureau has accordingly undertaken a study of the thermal expansion or contraction of a number of refractory materials from 20 to 1,800° C. or, in the case where softening occurs before reaching 1,800° C., to the maximum temperature possible.

The desired temperatures are supplied by a high-frequency induction furnace having a hollow cylindrical core of graphite 6 by 12 by $\frac{1}{2}$ inch, in which the heat is generated by induced current. The ends of the graphite cylinder are closed as much as possible to prevent oxidation of the graphite, which proceeds rapidly at high temperatures. Specimens approximately 6 inches long and 1 inch in cross section are set on end within a muffle, 3 inches in diameter, prepared from zirconium silicate. It was found by experiment that all of the special refractories, except graphite, available for use as part of a set-up within the furnace, proved unsatisfactory because of softening or cracking. Graphite also has a uniform and comparatively low rate of thermal expansion throughout the range of temperature used in this work. Shapes prepared from graphite are used, therefore, as the table on which

the specimen stands, as well as for transmitting the linear movement of the specimen to a micrometer dial. A piece of tungsten metal, 1 inch square and 0.015 inch thick, is placed between each end of the specimen and the graphite pieces to prevent reactions occurring at high temperatures between a specimen and the graphite. The temperature of the zone immediately surrounding the specimen is obtained by means of two thermocouples, inserted through the bottom of the furnace and placed so that one is near the top and the other near the bottom of the specimen. The thermocouples are removed at approximately 1,400° C., and temperatures thereafter up to 1,800° C. are obtained by means of an optical pyrometer sighted on the bottom of a graphite tube approximately $\frac{1}{4}$ inch from one side of the specimen. A micrometer dial fastened by an adjustable holder to a rack, having legs of fused quartz tubing, records the movement of the specimen as well as the movement of the table on which the specimen rests and the system which transmits this movement to the dial. Correction, to take care of the expansion of the system, was determined by observing the movements of materials of known expansion. The difference between the total recorded movement and the known expansion was taken as the correction necessary at any chosen temperature. Fused quartz was used for this work up to 1,100° C. and the correction curve extrapolated from 1,100 to 1,800° C. The latter part of the curve was also checked by expansion observations on a specimen of graphite.

Data with this apparatus have been obtained up to the present on periclase, graphite, and mullite from 20 to 1,800° C.

EFFECT OF AMOUNT, SIZE, AND GRADING OF COARSE AGGREGATE ON COMPRESSIVE STRENGTH OF CONCRETE

In Technical News Bulletins Nos. 115 and 127 (November, 1926, and November, 1927) were reported some of the results of an investigation of the factors governing the strength of concrete. Recently a more comprehensive study of the effect of the amount, size, and grad-

ing of coarse aggregate on the compressive strength of concrete has been made. For the study there were available the data resulting from the tests described in Technical News Bulletin No. 127, and, in addition, the results of a series of tests conducted during 1924.

For the earlier series Potomac River sand combined with Potomac River gravel and a single brand of cement were used in all the tests. Certain sizes of the sand and gravel were screened out so that the sizes of the resulting sands were 0 to No. 8, 0 to No. 4, and 0 to $\frac{3}{8}$ inch, and the sizes of the coarse aggregates were No. 4 to $\frac{3}{4}$ inch, No. 4 to 2 inches, and $\frac{3}{8}$ inch to $1\frac{1}{2}$ inches. Using these aggregates and the cement selected, 72 mixes were made in the proportions given in the table of mixes attached to the 1924 "Report of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete."¹ The amount of water used in each case was that which gave the slump called for in this table of mixes. The amount of sand used varied from a minimum of 15 to a maximum of over 60 per cent of the total aggregate.

As the mixes of the earlier series were designed to give 28-day compressive strengths, f'_c based on the equation $f'_c = \frac{14,000}{7w/c}$, in which w/c is the ratio of volume of the water to that of the cement, this equation was used as a basis for comparing the strengths of the resulting concretes. For the mixes in which the volume of the sand was less than one-half that of the coarse aggregate only four fixes gave strengths as great as that given by the equation. For the mixes in which the volume of the sand was at least one-half that of the coarse aggregate only seven gave strengths less than that given by the equation, and in all these seven mixes the coarse aggregate used ($\frac{3}{8}$ to $1\frac{1}{2}$ inches) was entirely lacking in the finer material, No. 4 to $\frac{3}{8}$.

In the latter series of tests Potomac River sand passing a No. 4 sieve was used throughout. Potomac River gravel, crushed limestone, and crushed blast-furnace slag were used as coarse aggregate.

¹ Appendix 16, Proc. Amer. Soc. for Testing materials, vol. 24, p. 376; 1924.

gate, and four different cements selected and prepared so as to give a wide range in strength were used. This series included tests with 160 different combinations of cements and aggregates. The results indicated that for each cement there was a characteristic water-cement ratio strength relation quite similar in form to that expressed by the equation

$$f'c = \frac{14,000}{7w/c}$$

For convenience, this relation for each cement has been referred to as its "normal" water-cement ratio strength relation. The tests showed (1) that for the various combinations of fine and coarse aggregates the amount of sand required to give a strength at least as great as that indicated by the normal water-cement ratio strength relation varied from about 33 to about 50 per cent of the total aggregate, (2) that the percentage of sand as determined gave a satisfactory workable mix, (3) that it was about the smallest percentage of sand which would give a workable mix, and (4) that these same percentages of sand gave higher strengths per barrel of cement per cubic yard of concrete than did any other combinations of the same aggregates; that is, they gave approximately the maximum economy of cement.

In a general way the second series of tests confirmed the conclusions from the first series, and the entire investigation furnishes useful suggestions regarding the formulation of a specification for the gradation of aggregates for concrete. A specification utilizing these suggestions might well require (1) that the aggregate should consist of at least 33 per cent sand, (2) that for aggregates having only 33 per cent sand the volume of the coarse aggregate of any one size should neither be greater than three times nor less than one-third that of the next smaller size except that no lower limit is placed on the amount of material of the largest size, and (3) that in case certain sizes of the coarse aggregate are missing the amount of sand should be in excess of 33 per cent but not greater than 50 per cent of the total aggregate. (The amount of aggregate passing any given sieve and retained on the next smaller sieve is here used to designate the aggregate of any one size.)

Within the range of the tests under discussion such a specification would not bar out many suitable mixes of concrete nor would it admit many unsuitable mixes. It is believed that it would be applicable for a considerable range in sizes and gradings, but in view of the fact that the first series of tests showed that the necessary amount of sand depended somewhat upon the size and grading of both the fine and the coarse aggregates, it is not to be expected that a specification of this sort would apply to all cases.

INFLUENCE OF DURABILITY TEST ON THE STRENGTH OF CONCRETE AGGREGATE

In the course of the investigation of the durability of concrete aggregates, the preliminary results of which have been described in Technical News Bulletin No. 123 (July, 1927), it was noted that the limestone specimens were subject to more or less disintegration in the boiling and drying test cylinders. To study this phenomenon further, a group of eight random samples of limestone block were selected, 2-inch diameter cylindrical test pieces approximately 2 inches high, or 2-inch cubes, being cut from each.

Before starting these tests each specimen was carefully examined for any cracks or other defects. The tests were carried out for 100 cycles, each cycle consisting of boiling in water for six hours and drying at 110° C. for 17 hours. As the test progressed careful visual examinations were made from time to time without any signs of disintegration being noticed.

Comparative compressive strengths were determined upon untreated samples cut from the same blocks of stone. The results of these tests are given in the following table. In every case but one the boiling and drying cycles caused a reduction of strength.

There is an average reduction of 36 per cent in strength as a result of the 100 cycles of boiling and drying treatment. In Sample No. 6 the average strength of the treated specimens is lower than the strength of the untreated specimens, the one case where the strength of the treated sample was

higher than the untreated being evidently due to the selection of a portion of the stone having a relatively high strength.

Stone No.	Strength	
	Untreated samples	100 cycles of boiling and drying
	Lbs./in. ²	Lbs./in. ²
1.....	8,500	5,450
2.....	9,700	3,160
3.....	5,600	4,970
4.....	6,750	4,240
5.....	7,850	3,070
6.....	3,500	4,240
7.....	3,500	1,890
6.....	7,550	5,870

PEANUT SHELLS IN GYPSUM FIBER CONCRETE

The use of gypsum fiber concrete and structural gypsum has created a demand for wood chips, which are mixed with calcined gypsum and water to form the concrete. These chips are hardwood planer shavings not over 1 inch in the longest dimension and not over one-sixteenth inch in thickness, being used in amounts varying from 0 to about 15 per cent by weight of the dry mix. The quantity demanded is sufficient to make the price of wood chips an appreciable item in the cost of construction. The use of peanut shells, now a waste product which can be secured at a price slightly higher than the transportation cost, to replace the wood chips in gypsum fiber concrete has been considered at the bureau.

Two types of gypsum were used in the following determinations: Gypsum I, a first settle, kettle calcined gypsum, and Gypsum II, a first settle, rotary calcined gypsum. These gypsums are representative of the calcined gypsum on the market for structural purposes. The following nomenclature is used throughout this article: Roman numerals I and II indicate the type of gypsum, the next figure; that is, 90 or 97, the percentage of gypsum by weight of the dry mix, the next; that is, 3 or 10, the percentage of wood chips or peanut shells, by weight of the dry mix, and the last figure the amount of mixing water, expressed as percentage of the dry mix.

The results obtained are given in the accompanying table.

Mix	Specimen size (cylinders)	Aging conditions	Compressive strengths	
			Peanut shells	Wood chips
			Lbs./in. ²	Lbs./in. ²
I-97-3-80.....	6 by 12	Oven dried..	948	1,318
II-90-10-60.....	6 by 12	do.....	277	682
	3 by 6	Air, 7 days..	1,284	1,815
I-97-3-60.....	3 by 6	Air, 14 days..	2,603	3,017
	3 by 6	Air, 28 days..	2,517	3,053
	3 by 6	Air, 7 days..	846	931
I-90-10-70.....	3 by 6	Air, 14 days..	1,338	1,631
	3 by 6	Air, 28 days..	1,341	1,549
	3 by 6	Air, 7 days..	1,327	1,945
II-97-3-60.....	3 by 6	Air, 14 days..	1,432	2,653
	3 by 6	Air, 28 days..	1,077	2,609
	3 by 6	Air, 7 days..	591	1,051
II-90-10-70.....	3 by 6	Air, 14 days..	747	1,722

Although the results, as a whole, indicate less strength for the peanut-shell mixes than for the wood-chip mixes there is still a possibility that the peanut shells may be substituted for the wood chips in gypsum-fiber concrete. The lower strength of the cylinders containing peanut shells is presumed to be due to the decaying of the shells before the gypsum dries out. An odor leading to this presumption is very noticeable with all the cylinders containing the peanut shells. It was also noticed that the strength of the 3 by 6 inch cylinders containing peanut shells was closer to that of the cylinders containing wood chips than in the 6 by 12 inch cylinders. This is thought to be due to a greater decay in the peanut shells in the larger cylinders, which dried more slowly. The use of disinfectants to prevent decay is now being considered, the shells are being treated with different disinfectants, the cylinders will be made, tested in the near future, and the results given in a later issue of the Technical News Bulletin. It is expected that if the decay is prevented the peanut shells will give more favorable results.

BRITISH STANDARDS FOR AUTO BUMPERS

Of interest to American manufacturers of automobile bumpers is the announcement that the Society of Motor Manu-

facturers and Trades, London, have agreed to fall in line with the United States, France, and Germany concerning bumper dimensions. Provisional standards of 20 inches from the ground for front bumpers and 21 inches for rear bumpers have been in operation in Great Britain since July, 1927. However, to conform with the general practice in the three countries mentioned, dimensions 2 inches less in both cases have been adopted by the leading British organizations. (Automotive World News, May 7, 1928.) Although bumpers are not as yet in general use in England, their popularity is slowly increasing.

STANDARD FOR STODDARD SOLVENT

Producers, distributors, and organized consumers of Stoddard solvent (petroleum distillate for use as a dry-cleaning solvent) are being circularized by the bureau for written acceptance of the commercial standard, approved by the general conference recently held at the Department of Commerce.

This commercial standard stipulates the minimum requirements for the preparation of this dry-cleaning solvent. At least 65 per cent of the known producers, distributors, and organized consumers must accept the standard in writing before it will be published by the Department of Commerce.

In the communication sent the industry the bureau stated that "while the action of the first general conference is based on a careful study of conditions and requirements, it will be susceptible of such modifications as future trends in the industry may render desirable. In order to make the standard conform with the best current practice in the industry, the conference appointed a standing committee, to which the industry is urged to submit any comments or suggestions that are considered beneficial. Such action will help the committee arrive at a decision when considering possible revisions a year from the effective date, which is March 1, 1928."

Members of the standing committee are: Lloyd Jackson, W. J. Stoddard, and C. C. Hubbard, of the National Associa-

tion of Dyers and Cleaners; A. L. Clayden, of Sun Oil Co.; E. E. Follin, of the Standard Oil Co. of Indiana; H. M. Hancock, of the Atlantic Refining Co.; and Dr. Harvey T. Kennedy, of the Bureau of Standards.

SEASONING, HANDLING, AND CARE OF LUMBER

The consumers' edition of "Seasoning, Handling, and Care of Lumber" has just been announced by the National Committee on Wood Utilization. This bulletin may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 15 cents per copy, or from any of the district offices of the Department of Commerce. In announcing the report, which is of value to manufacturers and distributors of lumber, as well as consumers, the National Committee on Wood Utilization said, "Shoddy construction is often due to the use of unseasoned lumber where good construction requires well-seasoned stock. This report has been prepared for consumers by a special subcommittee of consumers. It shows how the consumer should store and handle the lumber he buys; how well-seasoned lumber should be used, with particular reference to building and construction, and points out how, at a small extra expense, the house owner may eliminate sagging floors, cracked plaster, sticking doors, and all the other symptoms of the use of unseasoned lumber."

ACTIVITIES OF COMMERCIAL STANDARDS GROUP

Pyroxylin-Coated Fabrics.—There will be a general conference of manufacturers, distributors, and organized users of pyroxylin-coated fabrics at the Hotel Commodore, New York, on June 19, for the purpose of considering a proposed simplified practice recommendation for this commodity. The manufacturers of pyroxylin-coated fabrics are of the opinion that there is a large and unnecessary number of constructions offered to the trade, resulting in confusion in the minds of buyers and inability to make proper comparison between the goods so offered. A simplified practice recommendation has

been tentatively developed by the simplified practice committee of pyroxylin-coated fabric manufacturers.

Septic Tanks.—A preliminary meeting of manufacturers of septic tanks and officials of the Department of Commerce and the Public Health Service was held on May 2 with a view to taking steps to simplify the number of sizes of these tanks now produced. A committee of manufacturers was appointed at this meeting, and are at present engaged in making a survey of current practice in their industry to obtain data upon which to base a recommendation.

Cans.—The users of cans, represented by the preservers and packers of fruits, fish, and vegetables, are to be circularized by the Department of Commerce in cooperation with the National Canners' Association, in an effort to ascertain whether or not there is a possibility of eliminating some sizes of these cans which are slow making and serve to tie up capital of producers, wholesalers, and retailers.

Fire Engines.—A number of preliminary conferences have been held with manufacturers, fire chiefs, and officials of the National Board of Fire Underwriters, and the simplified practice committee of manufacturers has formulated a list of five standard fire engine pumping capacities. Their recommendation was presented to the convention of the Fire Department Institute at Hot Springs, Va., on May 28 and 29, and a general conference of manufacturers, distributors, and organized users will be arranged at a future date.

Concrete Ribbed Floor.—Manufacturers, distributors, and organized users of forms for concrete ribbed floor construction are being circularized for written acceptance of the recommendation covering forms for concrete ribbed floor construction, approved by a general conference held March 21, at Biloxi, Miss. Manufacturers, distributors, and users representing at least 80 per cent of the total volume of annual production must have accepted this recommendation in writing before it will be published by the Department of Commerce. The recommendation thereafter will be periodically

reviewed by a standing committee of the industry for possible revision or reaffirmation.

Surveys on Project.—Preliminary to submitting Simplified Practice Recommendation No. 54, Sterling Silver Flatware, to the industry for revision or reaffirmation, a survey is being conducted of the acceptors of this recommendation, to ascertain the average degree of adherence to the project, and to secure the views of the acceptors with regard to any modification that they may consider advisable.

Ball Bearing Sizes.—The chairman of the simplification committee for ball bearing sizes has notified the division of simplified practice that the collaboration of the committee with the ball and roller bearings division of the Society of Automotive Engineers has produced the desired results. Therefore the division has removed this project from its active files.

Asphalt.—The standing committee for Simplified Practice Recommendation No. 4, Asphalt, desires to hold a meeting at the time of the convention of the American Society for Testing Materials, which is to be held in Atlantic City during the last week of June, to consider suggested modification of the list of penetration limits. This meeting is scheduled for June 27. Aside from the members of the standing committee being present, it is desired that there be present representatives of those State and city engineers who are experiencing difficulty in specifying certain penetration limits for asphalt and who have recommended that these limits be narrowed down to a five-point range. Accordingly, invitations have been issued for the meeting.

Loading Platforms and Lift Trucks.—A conference of shippers, carriers, and warehousemen was held on June 6, under the joint auspices of the Bureau of Foreign and Domestic Commerce and the commercial standards group of the Bureau of Standards. The purpose of the conference was to consider the use and extension through cooperative effort of simplified methods of handling, moving, loading, and unloading goods; to pro-

mote the development of interchangeability in the equipment required for handling goods; and to promote the establishment of such dimensional standards as may be necessary to secure interchangeability of equipment.

Various phases of the subject of handling and loading goods were presented by experts in material handling, transportation, and warehousing. On account of the fact that interchangeability of platform and truck equipment is immediately feasible, it is proposed to undertake simplification in this class of equipment, first, with the idea of taking up in sequence thereafter the various other classes of handling equipment.

Ice Cake Sizes.—At a meeting of the simplified practice committee of the refrigeration industries, held in Detroit on May 18, a simplified list of five weights of ice cakes for household refrigerators was adopted, together with a list of maximum dimensions for each weight. The recommendation was developed by this committee, representing all branches of the refrigeration industry, as a result of careful surveys covering all existing standard sizes and cuts of manufactured and natural ice. A general conference of producers, distributors, and organized users of ice was held at the Department of Commerce on June 13, at which the recommendation of the committee was presented for action. Following this conference, the committee will next undertake to formulate a simplified list of dimensions for cooling compartments and door openings of household refrigerators.

Pipe Nipples.—A general conference to consider the establishment of a commercial standard for steel and wrought iron pipe nipples is scheduled for 10 a. m., June 29, in room 704, Commerce Building, Washington, D. C. The recommended standard for steel pipe nipples has been prepared by the Pipe Nipple Standards Corporation in cooperation with the pipe mills. The proposed standard for wrought-iron pipe nipples is similar in character and was suggested by the leading manufacturers of this material. All those interested in obtaining satisfactory standards for pipe nipples are invited to attend. Distributors, users, and master plumbers particularly are urged to be present.

Colored Vitreous Ware.—The manufacturers advisory committee on vitreous china plumbing fixtures has appointed a subcommittee to consider the practicability of standardizing colors of vitreous china plumbing fixtures to work in cooperation with manufacturers of enameled-iron plumbing fixtures and bathroom specialties in order that the colors used by various groups may be made to harmonize without undue diversification of lines.

Malleable Iron Brass Seated Unions.—A preliminary conference of manufacturers of malleable iron brass seated unions, held in New York City on May 28 voted to request the establishment of a commercial standard through the assistance of the Bureau of Standards and under its procedure. The United States Government master specification No. 393 for this product was used as a basis for discussion, and the manufacturers recommended a number of modifications which will be considered in further detail at a later meeting and then presented to a general conference of producers, distributors, and consumers for further comment and criticism.

NEW PUBLICATIONS

Additions to Supplementary List of Publications of the Bureau of Standards (beginning July 1, 1927)

Scientific Papers²

S572. Cause and removal of certain heterogeneities in glass; L. W. Tilton, A. N. Finn, and A. Q. Tool. Price, 10 cents.

Technologic Papers²

Volume 21, Technologic Papers of the Bureau of Standards; Nos. 328 to 352 (bound in cloth). Price, \$2.

Circulars²

Supplement to C25 (April 24, 1928), Standard samples issued or in preparation. Free on application to the Bureau of Standards.

² Send orders for publications under this heading, with remittance, only to Superintendent of Documents, Government Printing Office, Washington, D. C. Subscriptions to Technical News Bulletin, 25 cents per year (United States, Canada, and Mexico); 40 cents (foreign).

C359. United States Government master specification for netting, mosquito (unbleached bobbinet). Price, 5 cents.

Simplified Practice Recommendations²
(Elimination of Waste)

SPR67. Roller bearings. Price, 5 cents.

SPR76. Ash handles. Price, 5 cents.

SPR77. Hickory handles. Price, 5 cents.

Miscellaneous Publications²

M83. Standards Yearbook, 1928. (Bound in cloth.) Price, \$1.

Technical News Bulletin²

TNB134. Technical News Bulletin, June, 1928.

OUTSIDE PUBLICATIONS²

Some effects of carefully annealing optical glass. L. W. Tilton, A. N. Finn, and A. Q. Tool; Journal, American Ceramic Society (Columbus, Ohio), Vol. 11, No. 5, p. 292; May, 1928.

Paper research literature, VII. C. J. West (chairman, T. A. P. P. I. Committee on Bibliography) and B. W. Scribner; Paper Trade Journal (New York, N. Y.), Vol. 86, No. 17, p. 51; April 26, 1928.

Corrosion embrittlement of duralumin, IV. The use of protective coatings. H. S. Rawdon; National Advisory Committee for Aeronautics (Washington, D. C.), Technical Note No. 285; May, 1928.

Duralumin for airplane use. H. S. Rawdon; Mining and Metallurgy (New York, N. Y.), Vol. 9, p. 234; May, 1928.

Protection of duralumin against embrittlement. H. S. Rawdon; Brass World (New York, N. Y.), Vol. 24, p. 147; May, 1928.

Tarnish-resisting silver alloys. L. Jordan, L. H. Grenell, and H. K. Herschman; Metal Industry (London, England), Vol. 32, p. 427; April, 1928.

² Send orders for publications under this heading, with remittance, only to Superintendent of Documents, Government Printing Office, Washington, D. C. Subscriptions to Technical News Bulletin, 25 cents per year (United States, Canada, and Mexico); 40 cents (foreign).

² "Outside publications" are not for distribution or sale by the Government. Request should be sent direct to publishers.

Note on the crystal structure of electro-deposited chromium. F. Sillers, jr.; Transactions, American Electrochemical Society (New York, N. Y.), Vol. 52, p. 301; 1927.

Principles of electrolytic studies on corrosion. W. Blum and H. S. Rawdon; Transactions, American Electrochemical Society (New York, N. Y.), Vol. 52, p. 403; 1927.

Effect of antimony, arsenic, copper, and tin in high-speed tool steel. H. J. French and T. G. Digges; Transactions, American Society for Steel Treating (Cleveland, Ohio), Vol. 13, p. 919; June, 1928.

Written discussion on paper by Harder, Weber, and Jerabek on normal and abnormal carburizing steel. S. Epstein, p. 993, F. Sillers, jr., p. 999; Transactions, American Society for Steel Treating (Cleveland, Ohio), Vol. 13; June, 1928.

A new registering photodensitometer. E. A. Harrington; Portland Cement Association Fellowship (Care of Bureau of Standards, Washington, D. C.), Paper No. 15; March, 1928.

Methods for testing crazing of glazes caused by increases in size of ceramic bodies. H. G. Schurecht; Journal, American Ceramic Society (Columbus, Ohio), Vol. 11, No. 5, p. 271; May, 1928.

Survey of zoning laws and ordinances in 1927. John M. Gries. Mimeographed circular available on application to Division of Building and Housing, Department of Commerce, Washington, D. C.; March, 1928.

Survey of city planning and related laws in 1927. John M. Gries. Mimeographed circular available on application to Division of Building and Housing, Department of Commerce, Washington, D. C.; March, 1928.

A preliminary tabulation of city planning commissions of the larger cities of the United States. Mimeographed tables, available on application to the Division of Building and Housing, Department of Commerce, Washington, D. C.; March, 1928.

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